National Aeronautics and Space Administration

THE CRITICAL PATH

A FLIGHT PROJECTS DIRECTORATE PUBLICATION | 2019 SPRING ISSUE

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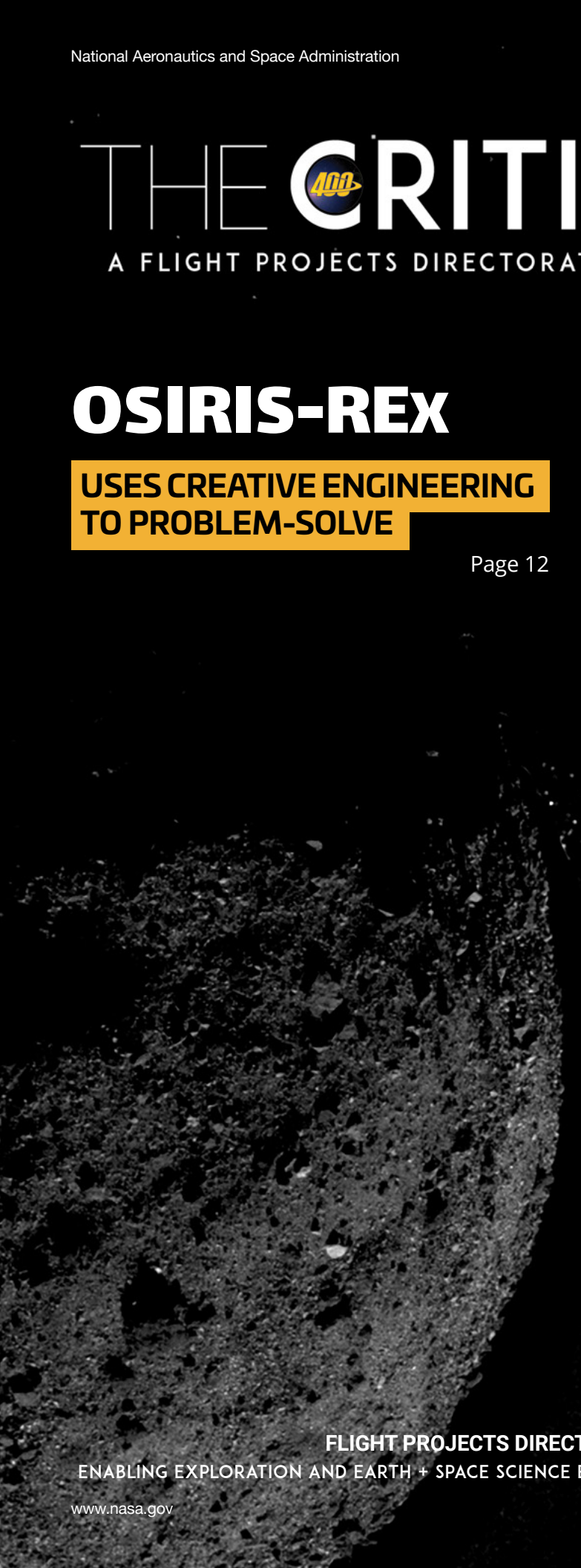

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Performing a final fit check of RRM3 external tools before launch. CREDIT: NASA / Chris Gunn

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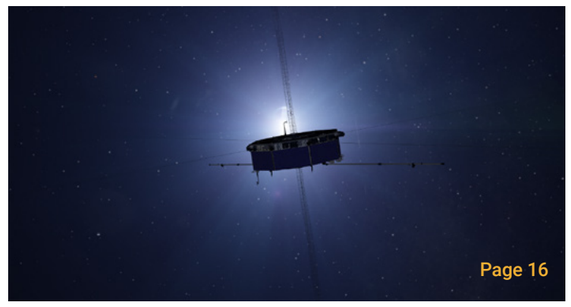

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THE CRITICAL PATH
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PUBLISHED BY THE FLIGHT PROJECTS DIRECTORATE

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Message from the DIRECTOR

Welcome to another edition of The Critical Path. A lot of things have happened over the last quarter, not the least of which was the 35-day partial government shutdown in December and January. This event impacted our teams in many ways, both at work and at home. How everybody responded to the shutdown was nothing short of amazing. Throughout the shutdown, within the Flight Projects Directorate, I saw many examples of people doing whatever was necessary to keep our missions flying, keep our tests running, and protect our high-value flight hardware, ground systems, and most importantly, our people. And for those who were not allowed to come into work, I well understand the struggles you faced with the uncertainty of when government would fully reopen and when you would be able to get on with your important work. You are a resilient group and I want to thank all of you for your dedication and perseverance.

Another big event over the past quarter was the successful launch of the Global Ecosystem Dynamics Investigation (GEDI) and Robotic Refueling Mission (RRM)-3 missions in December. Both systems are now installed at the International Space Station. I look forward to seeing the mission results. Congratulations to both teams!

It's always exciting to follow the progress of our flight projects in the operations phase. We've been following the progress of OSIRIS-REx, which launched in 2016 and is entering a new phase of its mission to return a sample from the asteroid Bennu. The Magnetospheric Multiscale mission recently broke a world record for the highest determination of location using GPS signals.

The James Webb Space Telescope's spacecraft element is now in the midst of thermal vacuum testing as we continue to march down the path of launching this amazing science mission in less than two years.

As we launch missions, we of course have to find new opportunities to build upon. Several of our proposing teams have just completed some outstanding proposals and review team site visits prior to the hopeful selection of these missions by NASA Headquarters. No matter the outcome, I greatly appreciate the teams' time and effort to bring new and exciting work to Goddard which is so essential to our future.

I also wanted to send out a friendly reminder that the annual Government Employee Viewpoint Survey (EVS) will be coming out soon. Please take a few minutes to fill out the anonymous survey when it is released in early May.

Lastly, we are gearing up for another busy summer with high school and college interns. The energy and results that the interns bring to the Center every summer is always inspiring. Thanks to all of the mentors out there for investing in our "people pipeline" and in our future.

David F. Mitchell
Director, Flight Projects
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A WORD FROM THE DEPUTY

In the latest video in our recurring series, FPD Deputy Director Tom McCarthy shares his thoughts on recovery, transformation, and the Zen principle of "not knowing."

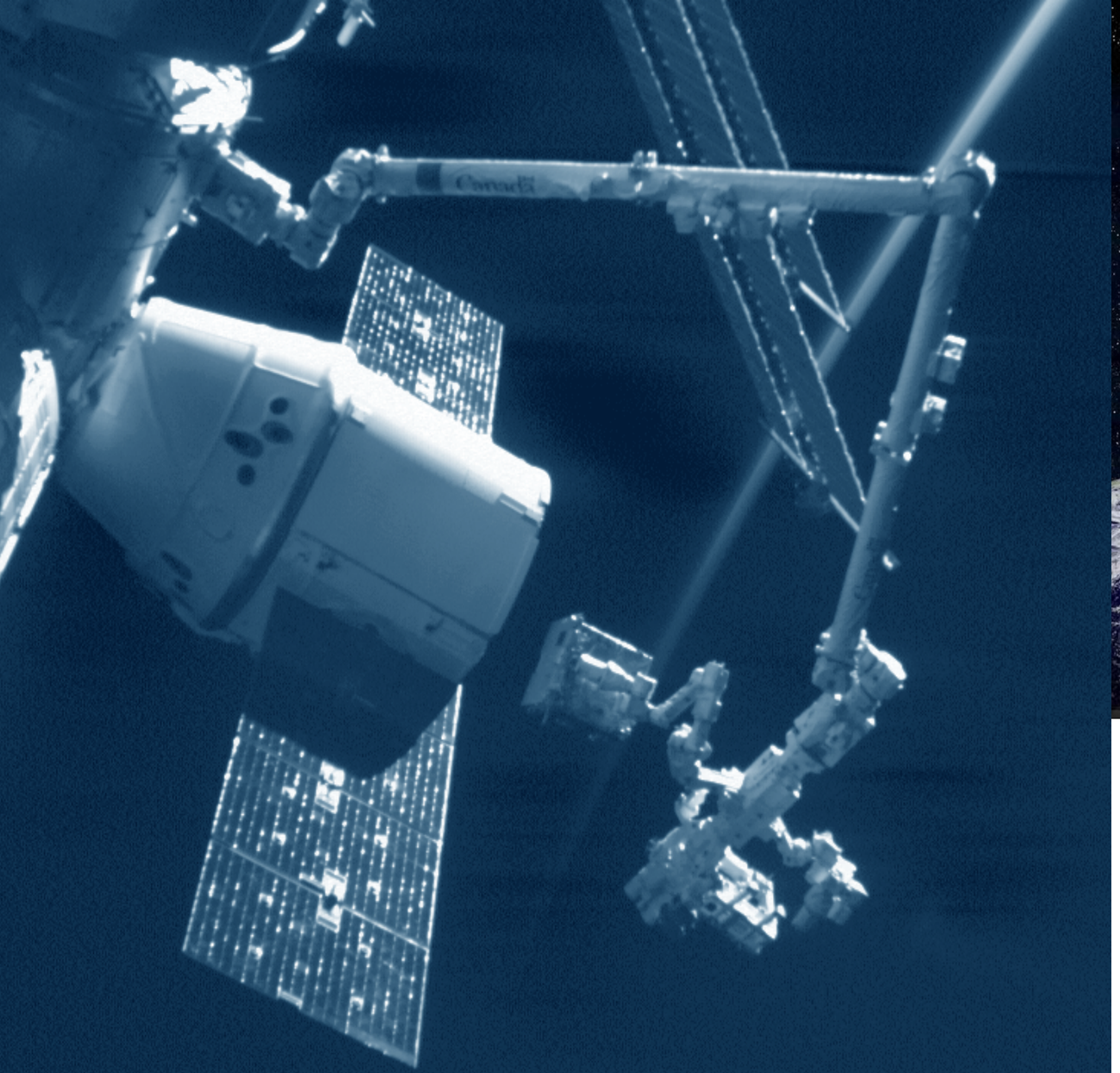
The Power of a SINGLE VOICE

The Equal Opportunity Programs Office (EOPO) and the Goddard Women's Advisory Committee held a 2019 Women's History Month Commemorative Program on March 27, 2019 at Wallops Flight Facility. This event featured our very own Dr. Wanda Peters as the keynote speaker on the topic of 'The Power of a Single Voice.' The 2019 national theme of the National Women's History Alliance is 'Visionary Women: Champions of Peace and Nonviolence' and recognizes women who have led efforts to end war, violence, and injustice and pioneered the use of nonviolence to change society. Over 60 people attended the program, which was transmitted via VITS and WebEx to NASA Headquarters and all Goddard campuses, including the Greenbelt Building 3 Auditorium, the Independent Verification and Validation (IV&V) facility in West Virginia, and the Goddard Institute for Space Studies (GISS). ■

Renee King / Code 120
EOPO Equal Employment Opportunity Specialist

Keynote speaker, Dr. Wanda Peters, FPD Deputy Director for planning and business management. CREDIT: ALLISON STANCIL-ERVIN, NASA WALLOPS FLIGHT FACILITY

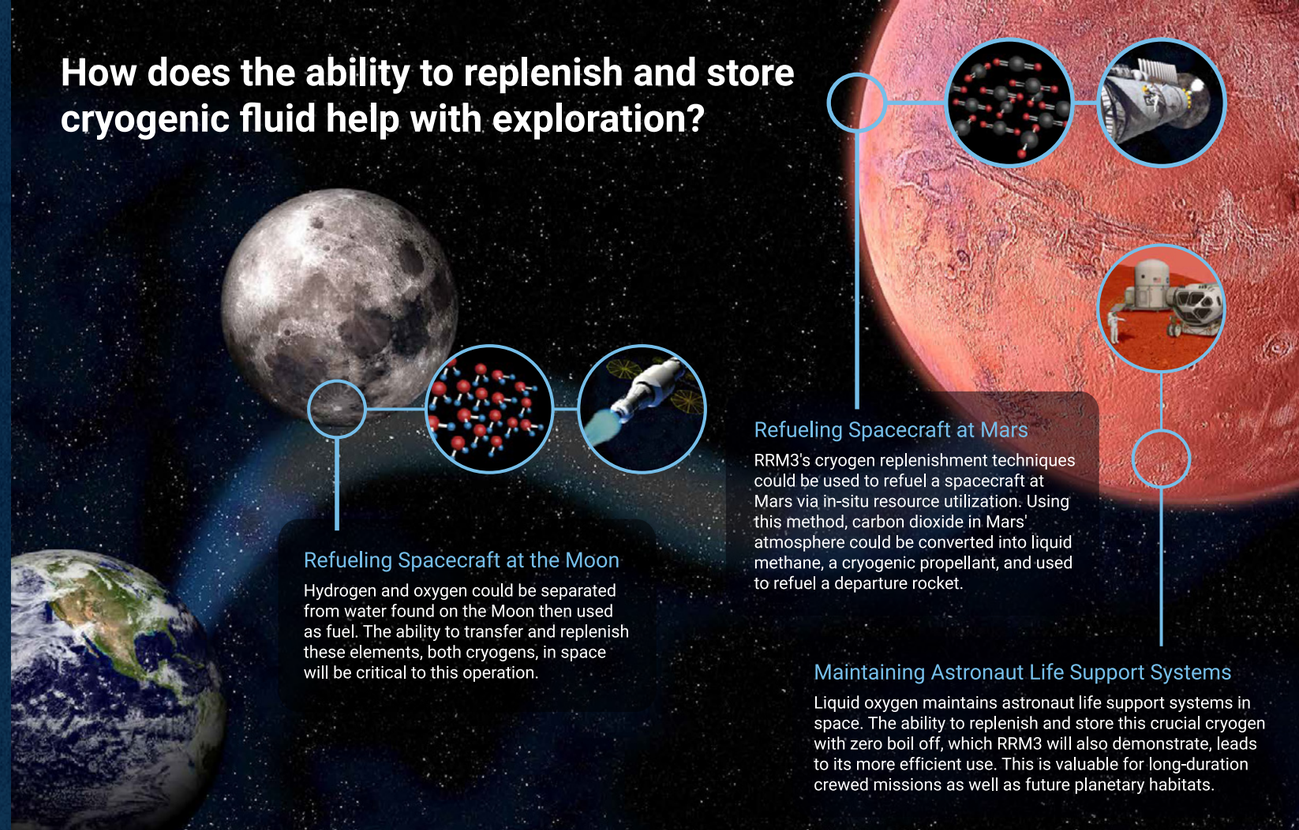
(left to right): Renee King, Women's Program Manager; Allysha Sneed, Women's Advisory Committee; Wanda Peters, Sandra Bowden, Women's Advisory Committee; David Pierce, Director, Wallops Flight Facility. CREDIT: ALLISON STANCIL-ERVIN, NASA WALLOPS FLIGHT FACILITY



FUELING FUTURE EXPLORATION

RRM3 to demonstrate refueling tools and techniques in space

THE INTERNATIONAL SPACE STATION'S DEXTRE ROBOTIC ARM HOLDS THE RRM3 PAYLOAD. CREDIT: NASA

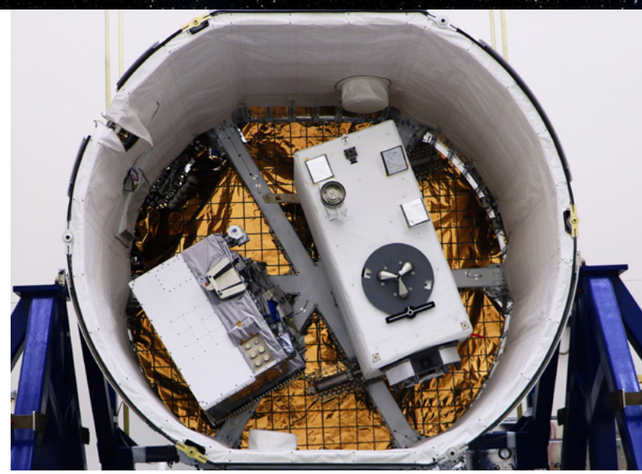


CREDIT: NASA

Spacecraft that use cryogenic fluids for fuel or coolant live on a timer, waiting for the inevitable moment when those fluids run out and the spacecraft loses maneuverability or the ability to conduct science.

But what if that countdown didn't have to signal the end? That's the possibility at the heart of the Robotic Refueling Mission 3 (RRM3), the latest phase of a project to demonstrate and test the technologies, tools, and techniques needed to robotically replace cryogenic fluids in space.

Launched on December 5, 2018, aboard the SpaceX Commercial Resupply Services 16 mission to the International Space Station, RRM3 envisions a future where a satellite's capabilities can be restored, where the availability of cryogenic refueling makes longer missions possible and can extend the life of otherwise disposable spacecraft. A refueling capability can also decrease the need to devote valuable spacecraft real estate to large quantities of cryogenic fluid.



RRM3 and GEDI payloads installed aboard the SpaceX Commercial Resupply Services (CRS) 16 Dragon spacecraft. CREDIT: NASA

Cryogenic fluids, such as liquid methane and liquid hydrogen, have extremely low boiling points and are useful for exploration missions because they produce enough thrust to launch a rocket from Earth or another

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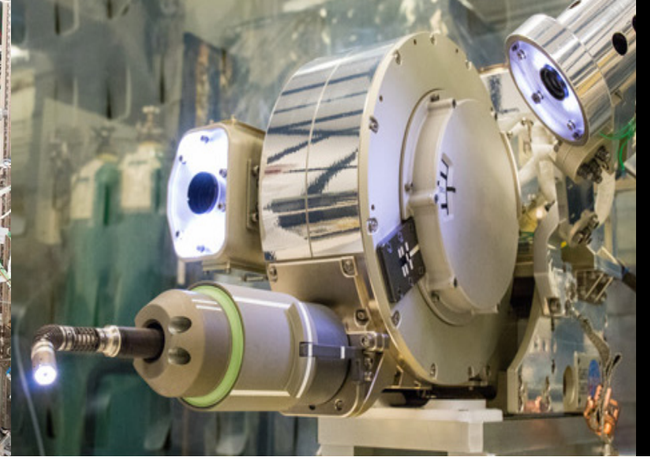
Astronauts Anne McClain of NASA and David Saint-Jacques of the Canadian Space Agency work on the RRM3 pedestal as they assemble the mission's trio of tools aboard the International Space Station. CREDIT: NASA

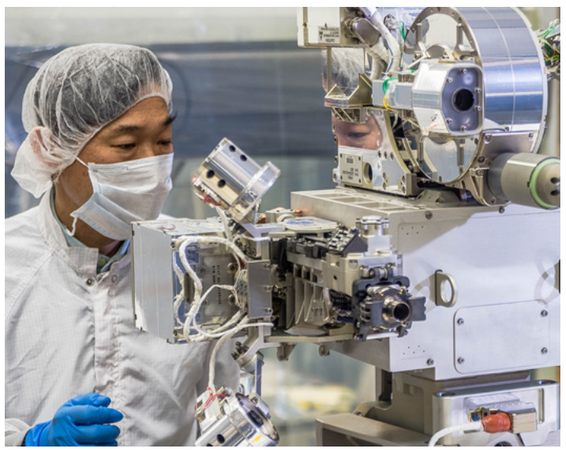
Finished with the tool assembly, astronauts Anne McClain of NASA and David Saint-Jacques of the Canadian Space Agency give a thumbs-up over the integrated RRM3 tools and pedestal aboard the International Space Station. CREDIT: NASA



Astronaut Anne McClain reviews the Visual Inspection Poseable Invertebrate Robot 2 (VIPIR2, shown at left). CREDIT: NASA

planet. Liquid oxygen is used to maintain life support systems for astronauts, while liquid helium can be used as a coolant. These fluids must remain at temperatures below -212 degrees Fahrenheit (-100 degrees Celsius) or colder to avoid turning into gases that could vent into space or over-pressurize the spacecraft's storage tank, a problem known as "boil-off."

RRM3 already demonstrated the first ever long-term storage of cryogenic fluid with zero boil-off. It will also test tools needed to transfer cryogenic fuel. RRM3 was designed to conduct a fuel transfer, but on April 8 the mission experienced issues powering up the cryogen coolers that control the temperature of the internal liquid methane supply. After several troubleshooting attempts, it was determined the coolers could not be powered up.



Edward Cheung, an engineer at NASA's Goddard Space Flight Center in Greenbelt, Maryland, performs a fit check of RRM3's three external tools to ensure that they're working correctly with the payload. CREDIT: NASA/GODDARD/CHRIS GUNN

While RRM3 can no longer perform a cryogenic fuel transfer, the rest of the mission will continue, providing critical lessons about the technology needed to store and transfer cryogenic fuel in space and serving as a step in a series of missions geared toward developing a refueling capability. The earlier stages, RRM Phase 1 in 2011 and RRM Phase 2 in 2014-15, showed that a robotic mission could cut through wires and blankets and manipulate caps to access the interfaces that had been carefully sealed shut on the ground under the reasonable expectation that they would never be opened again. They also tested inspection tools and machine-detectable stickers that could be used to guide robotic devices.

Inside the washing machine-sized RRM3 module are two tanks, as well as various types of transfer lines and interfaces. Outside the space station, the Dextre robotic arm will carry out the simulated fuel-transfer tasks using tools developed specifically for the mission: a modular, flexible multi-function tool that manipulates a specialized adapter on the end of one hose; a cryogen servicing tool that will grab a flex hose from the source tank and insert it into the receiver tank; and the Visual Inspection Poseable Invertebrate Robot 2 (VIPIR2), a high-definition, 6mm camera on the end of a flexible tube. VIPIR2 will be inserted into RRM3 plumbing to ensure that the cryogen flex hose is in the right location, demonstrating the use of a high definition wi-fi camera on an external payload.

Transferring the fluid between tanks in space is a complex process, so testing out the tools and operations is important data for future demonstrations. RRM3 will demonstrate the robotic connection of two separate transfer paths between the empty source tank and receiver tank. While both tanks are contained within RRM3, the source tank represents a supply on a servicing spacecraft and the receiver tank represents a spacecraft with a depleted cryogenic tank.

The first path will demonstrate tools and equipment needed to refuel existing cryogenic spacecraft never designed for in-orbit refueling. This task requires the Dextre robot to manipulate an 11-foot hose, secure to a cryogen fill port on the RRM3 front face, and then guide the hose down through internal plumbing to the entrance of the receiver tank. With one arm, Dextre will use the Cryogen Servicing Tool to grab the hose and insert it into the fill port. The VIPIR2 inspection camera will be on Dextre's second arm and will be inserted into an inspection line so that its borescope camera can confirm the hose is properly inserted into the receiver tank. This task also requires the use of a dual-motor-driven hose management device that will be controlled from Goddard during the mission to manage the amount of slack in the hose and prevent any zero gravity entanglements with the robot.

The second path represents a hose interface and mating port that are robot friendly and will be proposed for future spacecraft to simplify robotic refueling. For this demonstration, Dextre will grab the Multi-Function Tool 2 and connect it to the cryo coupler adapter on the end of a short transfer hose mounted to RRM3's front

Senior tools engineer Matt Ashmore examines RRM3's Cryogen Servicing Tool at Goddard. The tool will connect the storage tank to the receiver tank with a hose. CREDIT: NASA

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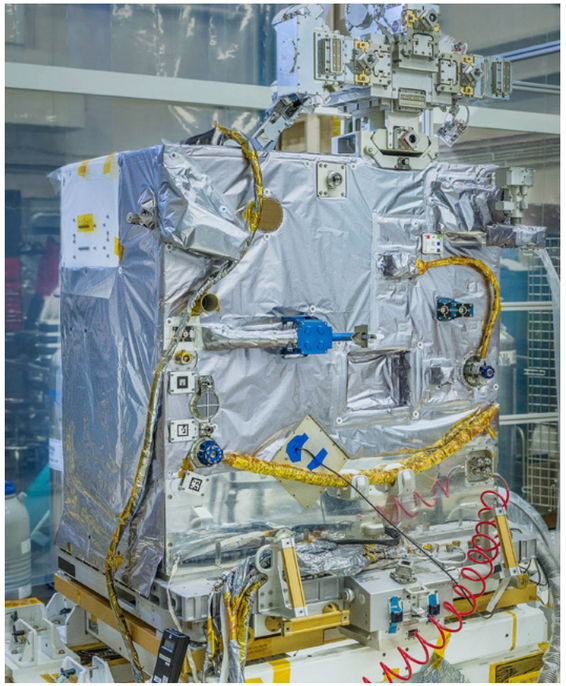


The RRM3 payload in a cleanroom at NASA's Goddard Space Flight Center. Once installed to the outside of the International Space Station, the mission's transfer and storage technologies will be put to the test. CREDIT: NASA/GODDARD/CHRIS GUNN

face. Dextre will unstow the adapter/hose and mate it to a cooperative port. Controlling both sides of the interface makes the task much easier.

To make future rendezvous and docking with satellites easier, RRM3 will complete additional evaluations of improved self-stick target decals used to mark areas of satellites detectable by machine vision to see how they work in the unique lighting conditions of space. "The first thing we've got to do is get up close and grab the satellite without harming it," said Mark Neuman, RRM3 hardware manager. "Using machine vision algorithms to correlate real-time camera views of these targets will provide the robot operators with accurate position information and simplify the challenging task of grabbing a satellite." The decals will be used with 2022's Restore-L satellite servicing mission and are already incorporated into other Goddard satellites like the Magnetospheric Multiscale (MMS) and others.

Just as critical as grappling with satellites and interfaces, RRM3 already demonstrated new methods of storing cryogenic fluid without having it evaporate. RRM3 successfully demonstrated the storage of 42 liters of liquid methane for four months with zero boil-off. This has been the first demonstration of zero boil off-cryogen storage in orbit. By maintaining cryogens at temperature through the use of cryocoolers and advanced multilayer insulation, the technology could eliminate the need for oversized tanks and extra propellant aboard spacecraft.

Storage and tool technologies as well as techniques tested by RRM3 may help designs for future refueling and servicing capabilities for NASA's Moon to Mars exploration mission. NASA is already working with industry to advance technologies to collect, process and use space-based resources for missions to the Moon and Mars, which will ultimately lower exploration costs. Hydrogen and oxygen separated from water ice found on the Moon could be used for exploration farther into the solar system. Or a future Mars transportation system could even be refueled by converting carbon dioxide from the Red Planet's atmosphere into liquid methane.

"Understanding the storage needs, tools and operations for refueling — it's kind of like being a pathfinder," said Neuman. "It's something nobody has really done before, and it's really blazing new trails for servicing in space." ■

Tracy Vogel / Code 440
Astrophysics Projects Division
Technical Writer

The Compact Thermal Imager

The RRM3 will also validate the Compact Thermal Imager (CTI), an instrument that will be used to observe Earth's surface. CTI is a compact thermal camera mounted in a corner of the RRM3 payload, which will image and measure smoke and fires, ice sheets, glaciers, and snow surface temperatures. CTI will measure transevaporation, or the transfer of water from soil and plants into the atmosphere — important for monitoring and understanding plant growth.

The CTI uses a relatively new photodetector technology known as Strained-Layer Superlattice, or SLS. In addition to being very small, measuring nearly 16 inches long and 6 inches tall, SLS consumes little power, operates at liquid-nitrogen temperatures, is easily fabricated in a high-technology environment, and is inexpensive. The demonstration's goal is to raise the SLS technology-readiness level to nine (TRL-9), meaning that it has flown in space and operates well under the extreme environmental conditions found in orbit.

Welcome Back!

(top left and top right) Goddard Director Chris Scolese welcomes back employees. (bottom, left to right) Roger Clason – Deputy Director of Code 700; Mike McGrath - Procurement Officer for GSFC; Rich Barney - retired Deputy Director of Code 300; Crystal Gayhart – Director of Office of Human Capital Management; Steve Shinn – CFO GSFC; Ray Ruboltta – Director Code 200. CREDIT: NASA

Goddard Center Director Chris Scolese welcomed back employees after the 35-day government shutdown. A panel of Goddard leaders addressed employee concerns and answered questions during the packed session held at the Hinners Auditorium.

FPD Director Dave Mitchell and deputies, Tom McCarthy and Wanda Peters, walked the halls in several buildings to welcome employees back to work. Dave shared his thoughts via an e-mail to the team:

"Our missions in FPD are a focus, for me, Tom, and Wanda. Our people and teams are our most important mission."

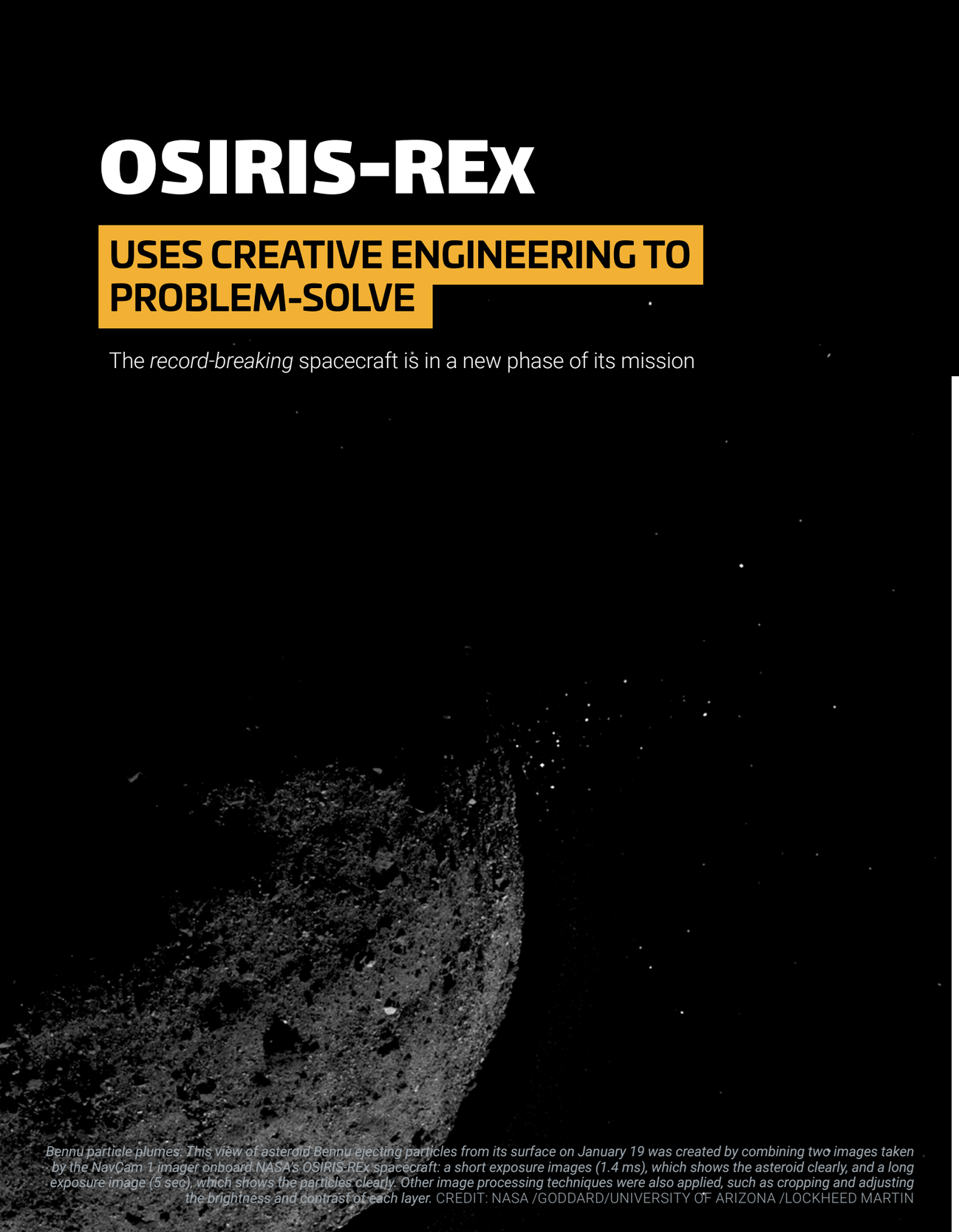
– Dave Mitchell

OSIRIS-REx

USES CREATIVE ENGINEERING TO PROBLEM-SOLVE

The *record-breaking* spacecraft is in a new phase of its mission

The Origins Spectral Interpretation Resource Identification Security-Regolith Explorer, or OSIRIS-REx, is entering the next phase of its record-breaking mission. The spacecraft has been using creative engineering to navigate an asteroid and make discoveries.



Bennu particle plumes: This view of asteroid Bennu ejecting particles from its surface on January 19 was created by combining two images taken by the NavCam 1 imager onboard NASA's OSIRIS-REx spacecraft: a short exposure images (1.4 ms), which shows the asteroid clearly, and a long exposure image (5 sec), which shows the particles clearly. Other image processing techniques were also applied, such as cropping and adjusting the brightness and contrast of each layer. CREDIT: NASA /GODDARD/UNIVERSITY OF ARIZONA /LOCKHEED MARTIN

The spacecraft launched in 2016 to study Bennu, an asteroid that may have answers about the origin of life and our early solar system. In December 2018, as people on Earth got ready to ring in the New Year, OSIRIS-REx entered Bennu's orbit, unlocking a wealth of new information and breaking a handful of records. And NASA announced in early January that OSIRIS-REx has discovered that Bennu is an "active asteroid," occasionally spewing streams of small particles into the space around the asteroid where the mission is operating.

"The particles at Bennu have been quite an interesting challenge," said Russell Carpenter, deputy project manager for technical at NASA's Space Science Mission Operations. "The spacecraft is moving slower in orbit than most people walk and most of the particles appear to be quite small, moving not much faster than the spacecraft. We set the threshold for a damaging impact very conservatively at about the same energy as a tossing a wad of paper into a trash can. Based on our observations, a tiny fraction of the particles can hit OSIRIS-REx that hard."

The spacecraft is the first to study a primitive B-type asteroid, rich in carbon and organic molecules and has already broken the record for the closest a spacecraft has ever orbited around the object it is studying. When OSIRIS-REx entered Bennu's orbit, the asteroid became the smallest object to be orbited by an Earth spacecraft.

Orbiting Bennu, a small asteroid with weak gravity, requires a lot of precision. The smallest of factors, like the light shining from the Sun, can knock the spacecraft off course.

"When you're in orbit of a small body like Bennu, those things become extraordinarily important in terms of being able to predict the position of the spacecraft in the future and being able to plan observations," says Rich Burns, project manager at NASA's Space Science Mission Operations.

One of the key ways that the OSIRIS-REx team has been able to keep track of the spacecraft's movements and account for any trajectory errors caused by the small forces around Bennu is through landmark navigation.

"Landmarks can be physical features such as craters, boulders, or other variations in topography or brightness. Our navigation software is able to match landmarks in images from the cameras with our Bennu models, which forms one of the primary measurements used for navigation," explains Mike Moreau, flight dynamics system manager.

By identifying the landmarks in the images that OSIRIS-REx takes, navigators can pinpoint where the spacecraft is and can predict where the spacecraft will be in the future, a technique that'll be crucial for the next phase of its mission.

OSIRIS-REx is now in the Sample Site Selection Campaign, the last phase before the spacecraft collects a sample from Bennu. For about a year, the spacecraft will map Bennu's surface. This year is a very challenging time in the mission for operations," explains mission operations manager Andy Calloway. "For example, in the detailed survey that spans March through May, the spacecraft is executing fourteen separate flybys, driven by two thruster-based maneuvers per week. The team

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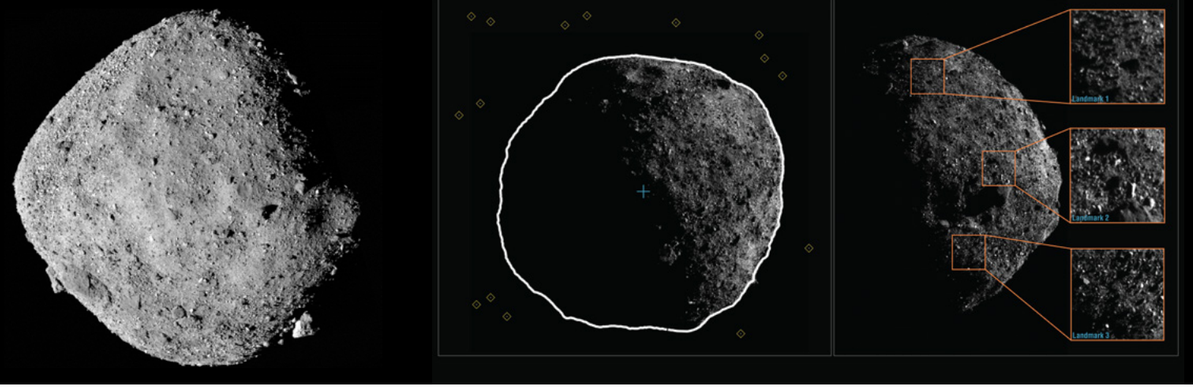


Stellar navigation vs. landmark-based navigation: During Orbital A, OSIRIS-REx transitioned from using the center of Bennu (relative to background stars) to using landmarks on the asteroid's surface for navigation. CREDIT: NASA/GODDARD/UNIVERSITY OF ARIZONA / LOCKHEED MARTIN/KINETX, INC.

is also building late update products at least three days per week to fine-tune those maneuvers and the science pointing and timing so that plans that are designed several weeks in advance are perfectly pointed at the intended target regions of Bennu." Scientists will use the data to decide the best location to collect a sample.

"It has to be a location that is safe, one that we can deliver the spacecraft to, and one where the surface of the asteroid is actually sample-able," explains Burns.

During the Sample Site Selection Campaign, scientists are also analyzing the composition of the asteroid to see which areas have the most scientific value.

"That fourth map, the science value map, will be an additional consideration in selecting a site. Which sample will be more valuable for a study on Earth?" says Burns. The ideal spot for the team is an area that checks all four of these boxes and has a 25-meter radius.

However, finding an ideal sample site is a little challenging. While mapping Bennu, OSIRIS-REx discovered that the asteroid's terrain is more rugged than scientists expected. There's a large number of boulders on Bennu's surface, which makes it harder to find a safe spot with rocks that are small enough for the spacecraft to collect. In fact, there are no 25-meter radius circles that are completely hazard-free.

"This means we have to improve the capability of the spacecraft after the fact," says Burns.

In addition to shrinking the size of the potential sample site, researchers are readjusting how they choose the location. The initial plan was to have an algorithm analyze the different maps of Bennu and decide on ideal locations based the four criteria: sample-ability, deliverability, safety, and scientific value.

"When we've taken in all this data at the global scale, those maps have been only somewhat useful in finding sample sites," says Ron Mink, OSIRIS-REx mission systems engineer.

In order to locate a sample site, the algorithm will have to work alongside the human eye. While the algorithm looks at the four maps to find a sample site, researchers on the ground will also be looking at the maps, picking out any sites that look safe and are boulder-free.

After choosing a site and rehearsing the sample acquisition maneuvers, OSIRIS-REx will be ready to make history. The spacecraft will exit its orbit, navigate to the sample site, and for 5 seconds, make contact with Bennu's surface.

At first, the maneuver seems simple: extend the Touch and Go Sample Acquisition Mechanism, TAGSAM, and scoop up some regolith on the asteroid's surface. However, this phase of OSIRIS-REx's mission requires a lot of careful planning and complex engineering.

The TAGSAM head has three nitrogen bottles attached, enough for three attempts at sample collection. Once the head connects with the surface, a blast of nitrogen from one of the bottles is released, stirring up dust and rocks on Bennu's surface. The regolith lifts off the surface and travels into the head of the TAGSAM, causing a containment flap to open. The debris and gas then enter a mesh container where the regolith is trapped and the gas can escape.

The OSIRIS-REx Touch and Go Sample Acquisition Mechanism (TAGSAM) is extended to scoop up some regolith on the surface of Bennu. CREDIT: NASA/GODDARD

"That was all new, what we consider new technology, that had to go through a lot of development and testing before we could say it was ready for flight and doing the job at Bennu," says Mink.

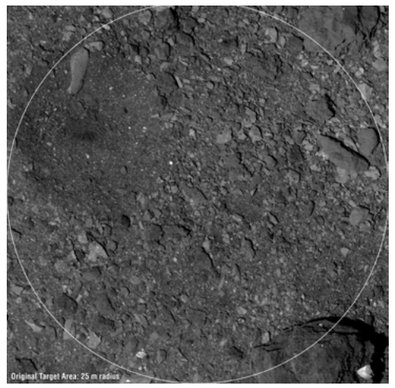
If the TAG phase is successful, then OSIRIS-REx will have at least 2.1 ounces of samples to bring back to Earth, making it the largest sample collected since the Apollo era and making OSIRIS-REx the first US mission to bring an asteroid sample back to Earth.

OSIRIS-REx is unlocking a lot of new knowledge about Bennu. The spacecraft is breaking records, making new discoveries, and providing knowledge that future generations of scientists will still be learning from. "We're the first people to be able to see measurements and images from this small world. Just being able to be a part of that discovery is inspirational, motivating, and very cool," says Burns.

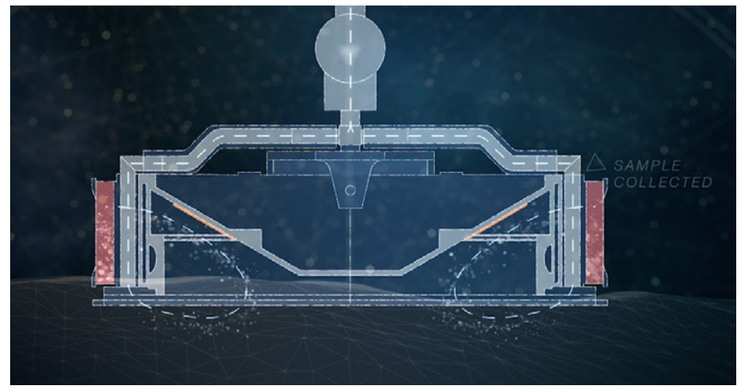
OSIRIS-REx will be entering its TAG phase in July 2020 and should return the sample to Earth by September 2023. ■

For more information, go to:
www.nasa.gov/osiris-rex

Ki Ki Hobbs / Code 130
OSIRIS-REx
Office of Communications
Multimedia Intern



(left) OSIRIS-REx candidate sample site and target area on asteroid Bennu: The original OSIRIS-REx mission design called for the spacecraft to target a hazard-free area with an 82-foot (25-meter) radius during sample collection. Bennu's high density of boulders means the team must prepare to sample a markedly smaller area, such as the loose regolith in the upper left portion of this PolyCam image taken on March 7. CREDIT: NASA



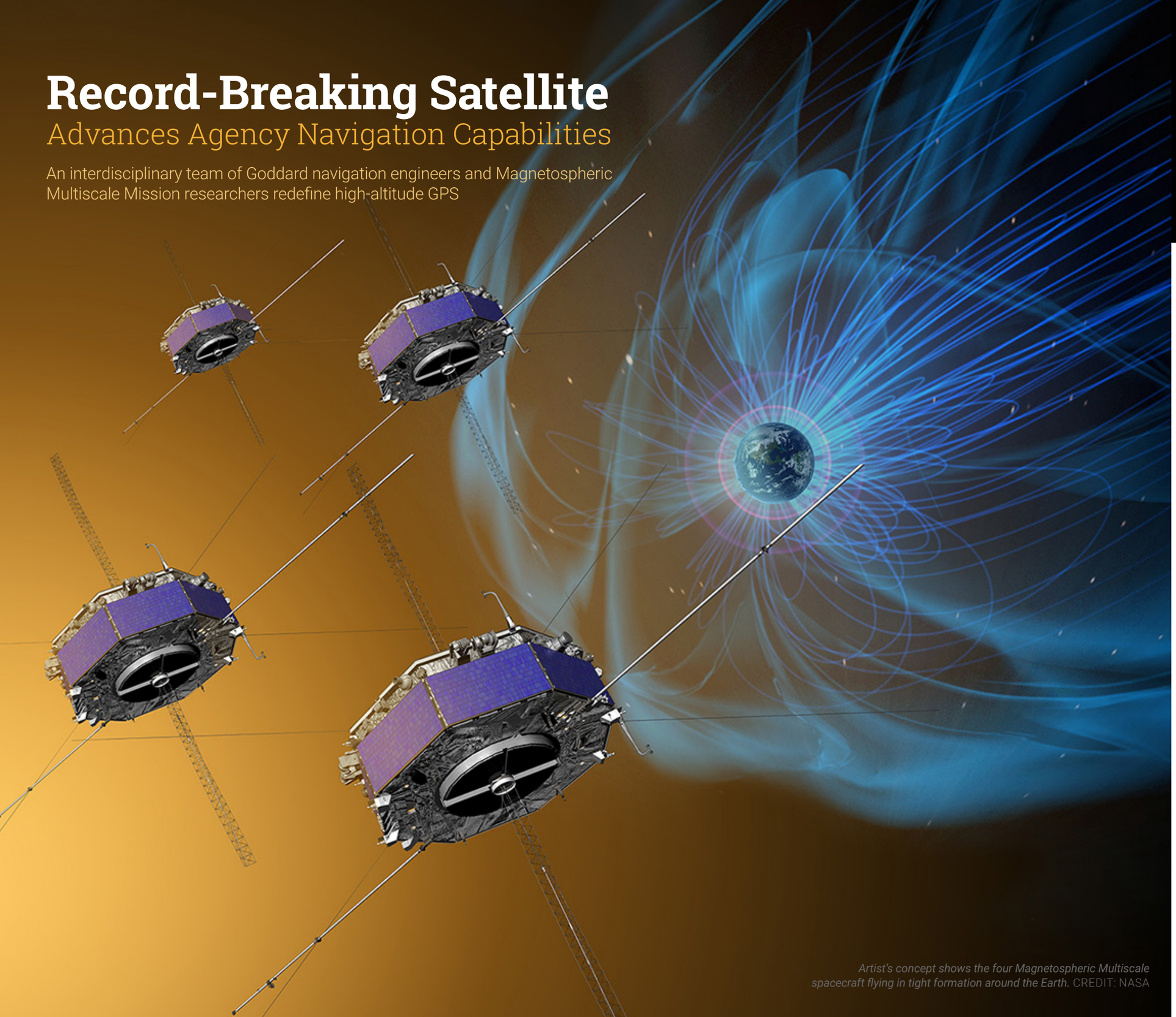
(right) OSIRIS-REx sample collection animation. CREDIT: NASA/GODDARD

Watch video

Record-Breaking Satellite

Advances Agency Navigation Capabilities

An interdisciplinary team of Goddard navigation engineers and Magnetospheric Multiscale Mission researchers redefine high-altitude GPS



Artist's concept shows the four Magnetospheric Multiscale spacecraft flying in tight formation around the Earth. CREDIT: NASA

The four Magnetospheric Multiscale (MMS) spacecraft recently broke the world record for highest determination of location using global positioning system (GPS) signals – for a third time. MMS's continued success may help NASA return to the Moon through the incorporation of similar signals into the navigation architecture of the Gateway, the Agency's planned lunar-orbiting outpost.

To study Earth's magnetosphere, the region of space dominated by the planet's magnetic field, MMS spacecraft maintain a highly elliptical orbit around Earth. A highly elliptical orbit has extreme high altitudes, apogees, and low altitudes, perigees.

The tight formation that the MMS spacecraft fly in requires highly accurate navigation data from the GPS satellites operated by the U.S. Air Force. The main GPS antenna signals enable navigation down on Earth, but precise high-altitude navigation requires these signals in addition to signals from the antenna's side lobes, which extend past Earth.

Communications engineers usually consider these side lobes wasted energy — signals sent out to the side of the direction an antenna is pointing. However, the signals can be used by satellites at high altitudes on the opposite side of the globe. (Such high-altitude missions fly above the GPS satellites on their own side of the globe.)

Previously, most engineers considered the upper limits of the GPS navigation in space (the Space Service Volume) to be an altitude of about 22,000 miles, or the altitude of satellites in geosynchronous orbit – until MMS.

On October 20, 2016, MMS won the Guinness World Record for the highest altitude GPS fix ever recorded at its 43,500 mile apogee. After an orbit change in February 2017, the spacecraft nearly doubled that record, receiving GPS signals a whopping 93,200 miles from Earth.

After navigation maneuvers conducted this February, MMS now has an apogee of over 116,300 miles from Earth, about halfway to the Moon. At this altitude, MMS continued to receive strong

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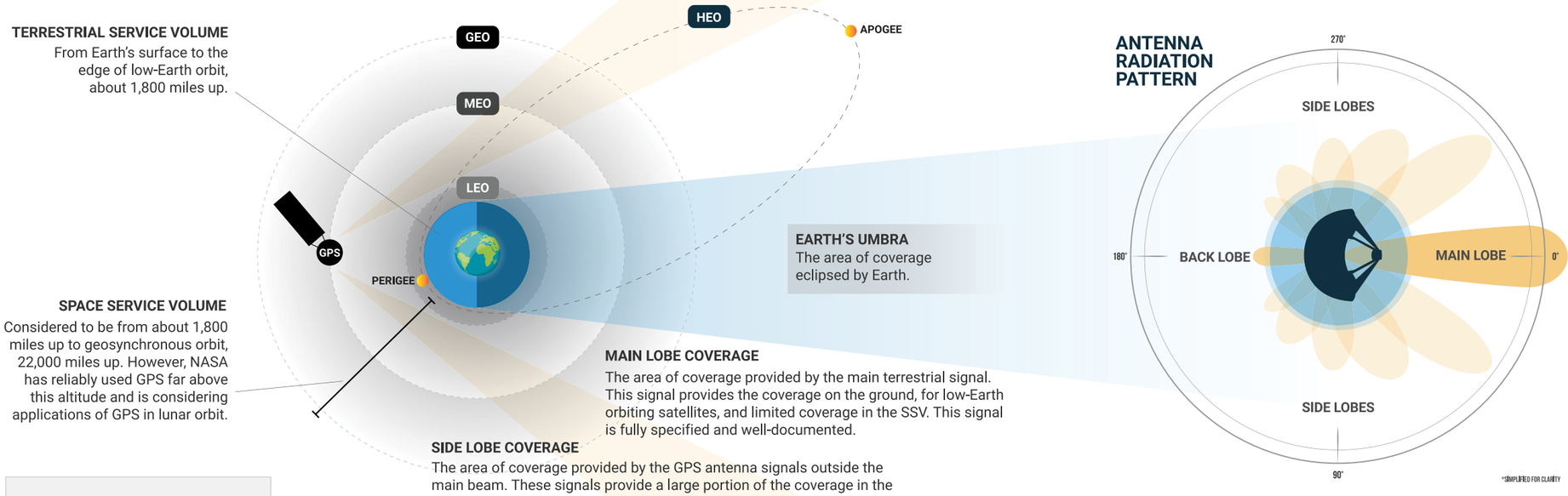


enough GPS signals to determine its position, once again shattering its own record. This demonstrates that reliable, GPS-based navigation extends well beyond geosynchronous orbit and that future missions can reliably use GPS at extreme altitudes.

"At the first apogee after the maneuvers, MMS1 had 12 GPS fixes, each requiring signals from four GPS satellites," said Trevor Williams, the MMS flight dynamics lead at GSFC. "When we began the mission, we had no idea high-altitude GPS would be such a robust capability."

MMS's orbit shift allows it to continue its mission to better understand the complex magnetic processes around Earth. MMS studies magnetic reconnection, in which magnetic fields collide and explosively release particles in all directions. Near Earth, reconnection is a key driver of space weather, the dynamic system of energy, particles and magnetic fields that can adversely impact communications networks, electrical grids and GPS navigation. Magnetic reconnection was long predicted by physicists, but not directly observed until the MMS mission.

During MMS's recent navigation maneuvers, the formation changed from a tetrahedron to a straight line, gathering data not available to scientists during normal operations.

"MMS usually flies in a close, tetrahedral formation," said Thomas Moore, the project scientist for MMS at NASA Goddard. "During the orbit-raising maneuvers, the spacecraft became a 'string of pearls,' which gave us unique data about the magnetosphere that may further our understanding of magnetic reconnection."

MMS's tight configuration and record-breaking GPS fixes would not be possible without the mission's Navigator GPS Receiver, an instrument developed at NASA Goddard. It can detect faint GPS signals while withstanding the harsh radiation environment within the magnetosphere. NASA has made this revolutionary technology available for licensing through the Technology Transfer program, ensuring that commercial enterprise can also benefit from this innovation.

NASA is exploring the upper limits of GPS service with more than just MMS. NASA navigation experts have run simulations demonstrating that these services could extend even further when taking into account the collection of six international GPS-like constellations. These constellations are collectively referred to as Global Navigation Satellite Systems (GNSS).

In fact, NASA simulations show GNSS signals could even be used for reliable navigation in lunar orbit. Engineers are considering applications of GNSS in developing the Lunar Orbital Platform-Gateway, an outpost that will enable sustained lunar surface exploration.

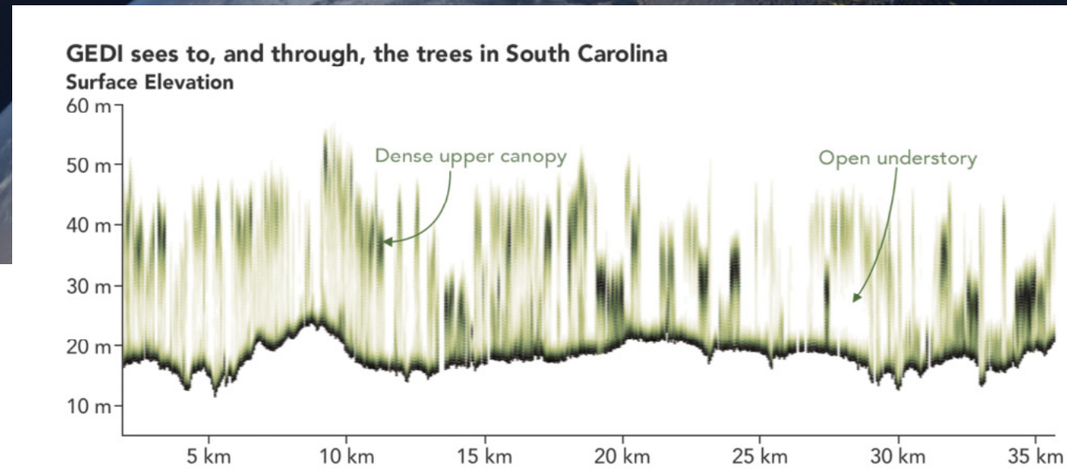
"We're working with the international community to document GNSS performance for space users, including side lobe signals," said Joel Parker, a Goddard navigation engineer representing NASA internationally in GNSS policy. "A better understanding of GNSS capabilities will allow high-altitude missions to take advantage of the robust navigation signals they provide."

Thanks to MMS and Goddard navigation engineers, the sky is no longer the limit. ■

Danny Baird / Code 450
Technical Writer

NASA

RETURN OF THE GEDI's FIRST DATA



Profile measurements of a South Carolina woodland from the winter of 2019. Darker greens show where the leaves and branches were denser, while lighter areas show sparser parts of the canopy. CREDIT: JOSHUA STEVENS, USING GEDI DATA FROM UMD

Launched in December 2018 to the International Space Station, the Global Ecosystem Dynamics Investigation (GEDI) was built with lasers that can make three-dimensional maps of Earth's forests and landforms. In January 2019, those lasers were turned on for the first time, giving scientists a first glimpse of the detailed insights it can provide.

GEDI's primary mission is to decipher forest structure: how tall the trees are, how densely their branches fit together, how much space lies between treetops and tree trunks, and how the branches are arranged from top to bottom. Knowing such details can foster a better understanding of how trees store carbon and what happens to that carbon when they are cut down or disturbed. Forests also support numerous plant and animal species, so understanding the structure can help biologists better understand habitats and biodiversity. The instrument uses sensitive light detection and ranging (lidar) technology to measure not only the elevation of the canopy and the forest floor, but the structure in between—a first for spaceborne instruments. The eight lasers scan a path roughly 4 kilometers (2.6 miles) wide and fire photons of light 250 times per second to capture detailed profiles of forests, fields, and hills. When all eight paths are analyzed together, they yield a high-resolution, 3D view of Earth's surface.

The raw data from GEDI offer a two-dimensional view of forest. The image above shows profile measurements of a South Carolina woodland from the winter of 2019. Darker greens show where the leaves and branches were denser, while lighter areas show sparser parts of the canopy. The data and processing shown here are preliminary, but they provide a good preview of what is to come.

"GEDI will provide a vertical record, not only of how tall trees are, but how much canopy material there is at any height," said Ralph Dubayah, GEDI principal investigator and a professor at the University of Maryland. "GEDI will make more than 10 billion individual observations of this canopy structure, which is orders of magnitude more than we have ever had."

GEDI uses eight laser beams to detail the forest structure. CREDIT: JOSHUA STEVENS, USING GEDI DATA FROM UMD - IMAGES FROM VIDEO

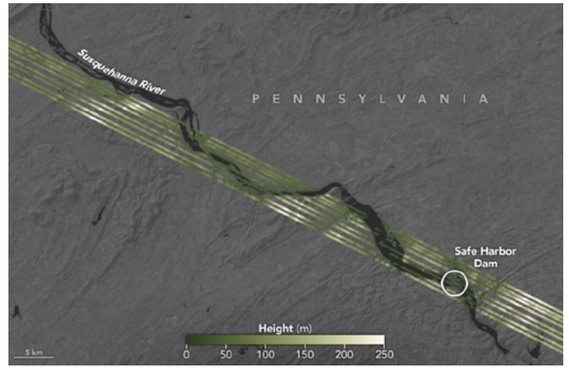
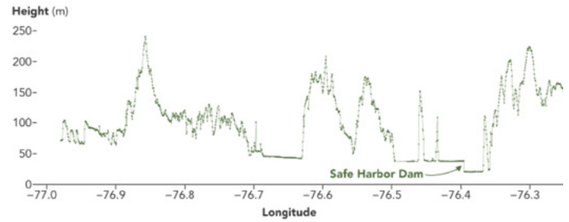


Image of the hills and fields on either side of the Susquehanna River in southeastern Pennsylvania. CREDIT: JOSHUA STEVENS, USING GEDI DATA FROM UMD

GEDI provides an intricate three-dimensional map of forest canopies. CREDIT: JOSHUA STEVENS, USING GEDI DATA FROM UMD - IMAGES FROM VIDEO



Profile of the hills and fields on either side of the Susquehanna River's winding riverbanks in southeastern Pennsylvania. CREDIT: JOSHUA STEVENS, USING GEDI DATA FROM UMD

"We are very excited that GEDI is now in orbit and taking measurements," said Michelle Hofton, a professor at the University of Maryland and a GEDI co-investigator. "This ability to precisely capture Earth's surface structure and its underlying topography is unique to GEDI. We're thrilled at the expansive coverage we're getting every day and looking forward to the discoveries that can be made using the data."

"It took a combination of high-powered lasers, sensitive detectors, precisely-designed optical components, high-speed electronics, and on-board software algorithms for GEDI to be able to make these challenging measurements," said Bryan Blair, GEDI's deputy principal investigator and instrument scientist. "This is a truly unique sensor that can make these detailed measurements of the canopy top, the canopy interior, and the ground below, even in the most challenging tropical and dense temperate forests." ■

Jessica Merzdorf / Code 130
Office of Communications
Earth Science Writer

Mike Carlowicz / Code 613
NASA Earth Observatory
Chief Technical Writer

NASA Earth Observatory images by Joshua Stevens, using GEDI data Courtesy of Michelle Hofton/University of Maryland

Watch video

FOCUS ON FACILITIES

Teamwork Overcomes Mother Nature and Old Facilities During Shutdown

While most of us had an unexpected winter break called a Government Shutdown, the combination of old facilities and cold temperatures took no break. On the weekend just prior to our return from the shutdown, Building 29 experienced a significant flood. According to the Facilities Management Division (FMD), a fourth-floor mechanical room coil froze and then ruptured, flooding parts of the building, including the accumulation of over 1100 gallons of water in a nearby elevator pit. Code 400 Laser Communications Relay Demonstration (LCRD) and Restore-L project space was in the line of fire. The FMD had knowledge of the conditions that contributed to the event and was awaiting repair work. However, the impact of cold winter temperatures was unavoidable.

Fortunately, furlough-excepted critical staff were on hand to discover the breach before impacts became truly catastrophic. In spite of quick discovery, LCRD and Restore-L spaces sustained some damage to finishes and minor equipment damage.

The building facilities operations manager (FOM), FMD, Akima (FMD's support service contractor) and dedicated Flight Projects Directorate (FPD) project staff jumped into action quickly to address the situation. LCRD and Restore-L staff worked to provide temporary housing elsewhere for Akima's clean-up and restoration work. The entire effort happened in under a week and staff were able to return to the area by our second week back.

Recovery efforts after major events are never easy. Considering this event coincided with the Center's focus on returning to post-furlough normalcy, the dedication of those involved deserves highlight. NASA is an organization of great teams, especially within Code 400. KUDOS and thanks to all those within and outside of Code 400 for their coordinated and proficient response.

Project Development Steps to Consider for Timely Coordination of FMD Construction Services

As most Code 400 staff understand, planning a flight project mission is an intricate process. So often however, our focus on the developmental requirements of the project override our consideration of support services needed for facilities in Phases B and C of the project lifecycle, and the time they require.

Consideration of the following four steps will ensure timely coordination of FMD services to accomplish your flight project facility modification.

1. **FMD Planning Support** – It is never too soon to create a Management Operations Services and Information (MOSI) ticket for planning services. Planning the project can require weeks to months depending on complexity. Good planning on the front end usually saves time during engineering, project management, and ultimately during construction. Greater understanding of related requirements and stakeholders leads to a smoother process downstream. Pay now or pay later.

2. **Task Plan** – The contractor is allowed a period of time to respond to a Request for Task Plan for services. The allowable period to develop a task plan is 7 to 21 calendar days.

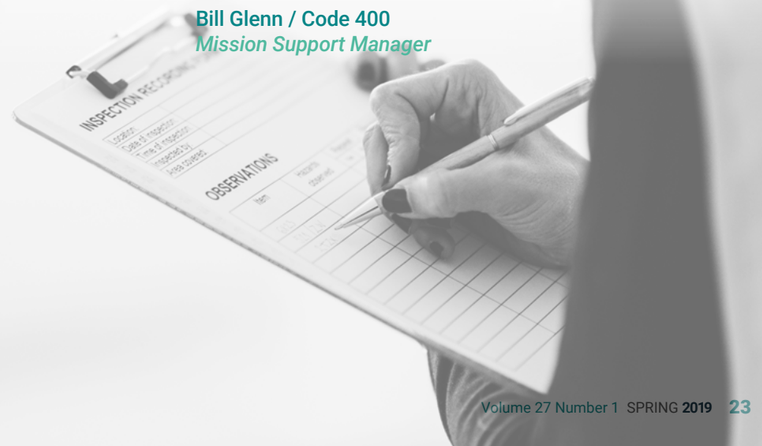
3. **Design Task Order** – All construction services begin with the issuance of a task order to the contractor for design. The period required for design can span from 36 to 135 calendar days, depending on cost and scope.

4. **Construction Performance Period** – The contractor is allowed a period of 44 to 181 calendar days based on the project development approach and estimated cost of construction. An estimated construction cost greater than $500K may exceed 181 calendar days to complete. A performance period greater than 181 calendar days is a negotiated period.

As you can see, depending on the extent of facilities modifications needed for a flight project support facility, significant time may be necessary. The most successful effort will be one that engages FMD as early as possible in partnership to meet our requirements. A good default period of notice is 1 year prior to need (not including the need to find space, if this is a factor.)

If you would like a detailed breakdown of the matrixed criteria that define specific time allowances, contact me. Always consider them in timing service initiation. ■

Bill Glenn / Code 400
Mission Support Manager



BE OPEN-MINDED.

The Flight Projects Directorate (FPD) Diversity and Inclusion (D&I) Committee took on a bold initiative to foster better communication in 2019.This values-based leadership approach intends to help in overcoming and understanding **unconscious bias** through a year-long journey of activities, conversation and awareness.The initiative will explore how we can individually contribute to the community and how our contributions affect decisions, outcomes and our teammates as we work to achieve mission success.

Unconscious bias is our attitudes and behavior toward other people. It can be influenced as much by our instinctive feelings as by our rational thought processes. It can lead us to make assumptions and take action based on those biases. This results in a tendency to rely on stereotypes, even if we don't consciously believe in them.

Last spring, the committee spent time together in a day-long retreat to better understand our organization which is the first step toward overcoming unconscious bias. We then invited the FPD community to participate in workshops last fall to start the conversation about this topic and to encourage more people to understand the premise of unconscious bias.

With the foundation set, the committee believed that we needed to do something to reach more members of the broader Goddard community and to promote conversations.

In March, members of the committee papered the campus with flyers promoting the first value of this campaign: **BE OPEN-MINDED**, or welcome new ideas without prejudice. Being open-minded is a choice you make when you enter into a conversation, read an article, watch the news, or engage in another method of receiving data.You are participating in that activity with previous thoughts about the person giving the information, the subject matter, the delivery method, the location, and other nuances. Understanding where you are coming from allows you to overcome your unconscious bias, thus empowering you to be more receptive to new or contrary ideas.

The committee has also transformed the FPD D&I website into a resource for you to find information on this initiative. Throughout this journey, it will be updated with activities and tools to bring to your organizations, work groups, and teams. To enable your teams to "be open-minded," the committee offers a short group activity/game that encourages the team members to learn more about each other. We played this as a committee and learned a lot about each other. Additionally, other organizations have played it and found it helped build a stronger foundation for collaboration and understanding.

Being open to new thoughts and practices may seem like an easy concept to support, and we all have a natural, instinctive reaction to believe we do. Though having our minds jump to a conclusion or an assumption without complete information is also a natural, human reaction that we all have. Using these activities to build new habits, to develop an instinct to pause and ask open questions can help us better understand the people that we interact with every day.

Why is open-mindedness important? Facilitating inclusiveness makes everyone feel valued and shows that differences are embraced. The result is empowered employees who openly share their diverse perspectives, and that will help NASA reach new heights.

We will continue our initiative to battle unconscious bias by highlighting new values and related activities throughout the year. Please continue to seek information and help us conquer unconscious bias by visiting our site regularly, as it is updated for each new value highlighted. ■

For more information, go to: http://bit.ly/fpdopenminded

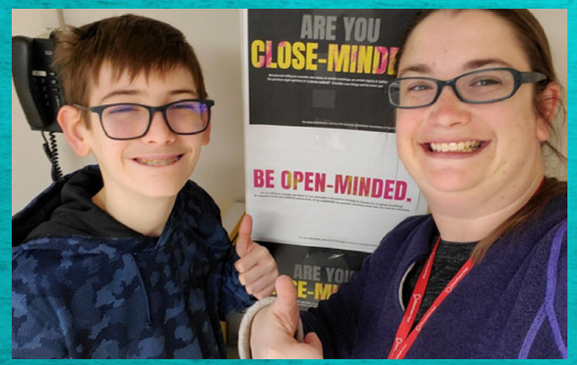
Tara Dulaney / Code 450
Matt Ritsko / Code 155
D&I Committee Members

D&I Committee lead Donna Swann (right) led a team, including Celina Hanewich (left), who gave up a Sunday afternoon to post 'Open-Minded' flyers throughout Goddard. CREDIT: NASA/GSFC

FPD senior staff recently engaged using the D&I Open-Minded discussion starter tools. CREDIT: DONNA SWANN

Tara Dulaney. CREDIT: NASA/GSFC

Liz Prince (472) (left) and Katie Mazur (474) learn something new about each other during the group activity. CREDIT: NASA/GSFC



Jen Poston and her son Anthony. CREDIT: NASA/GSFC

Kadie Esi. CREDIT: NASA/GSFC

Cathy Richardson

Earth Science Projects Division (Code 420)

Associate Director and ESM/RPP Program Manager

Born Midland, Michigan

Education Master of Mechanical Engineering: University of Maryland
BS Aerospace Engineering: Virginia Polytechnic Institute and State University

Cathy is the associate director of the Earth Science Projects Division (ESPD, Code 420). She also serves as the program manager for the Earth Systematic Missions Program within the Earth Science Division and the Reimbursable Projects Program within the Joint Agency Satellite Division, both at NASA Headquarters.

Life Before Goddard

Early on Cathy knew she wanted to go into engineering. She chose her specialization in aerospace following the Challenger Space Shuttle disaster. She knew she could use her expertise and career to focus on bettering flight projects. In college, she worked with a team to build a near-full-scale model of the National Aerospace plane that was later flown in a military cargo aircraft to the Paris Air Show for display. This experience confirmed her desire to work in the field, where she secured her first job as a structural analyst for Swales Aerospace. At Swales she supported flight projects at Goddard, the Naval Research Lab, and Johns Hopkins University. In this capacity she continued to develop additional knowledge and became a subject matter expert in structural, optical, thermal performance analyses, predicting on-orbit distortions, and pointing errors of complex optical systems. She was also the product development lead for the baffle subsystem of the Far Ultraviolet Spectroscopic Explorer instrument.

Life at Goddard

Cathy began her career onsite at Goddard in 1999 as an instrument manager for Orbital. She managed two contracted instrument series for the Polar Operational Environmental Satellite (POES) project. In this role, she successfully delivered eight instruments and supported two POES launches, coordinating activities with the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) and the European Space Agency (ESA).

In 2014, Cathy was appointed as the instrument manager for two contracted instruments for the Geostationary Operational Environmental Satellite (GOES-R) series during its formulation phase. She transitioned to serve as an in-house instrument manager, where she supported a number of other instruments including the Thermal Infrared Sensor (TIRS), a $140 million GSFC in-house instrument build. Cathy managed the instrument project from its inception through delivery to the spacecraft vendor. This instrument was added a year into the mission's development and successfully overcame schedule challenges to meet delivery within 3-1/2 years.

Cathy then transitioned from instrument management to become chief of the Instrument Management and Systems Office (then Code 505) before being called by the Center Director to lead the development of one of the largest and most complex instruments ever built on Center—the Advanced Topographic Laser Altimeter System (ATLAS). ATLAS had been experiencing significant programmatic and technical problems that required a full re-baseline. While working on ATLAS, Cathy focused on building a strong team and hiring talented individuals specifically suited to the project's needs. She reassigned staff members to positions best suited to their strengths while restructuring communication paths. During this time Cathy learned that the technical challenges that accompany every mission can be overcome by being transparent about these challenges and addressing them successfully. The instrument was launched in 2018 and is successfully providing science data today.

Cathy Richardson recently shared her experiences with Program Analysis and Control (PAAC) employees. CREDIT: CHRIS GUNN

Cathy Richardson, Deputy Program Manager, Earth Science Projects Division

CREDIT: NASA

Cathy joined the Earth Science Projects Division (ESPD) in 2016 as the deputy program manager and was recently promoted to program manager. Since onboarding with ESPD, her focus has been process improvements and increased efficiencies. Under her leadership, the Division implemented its own Document Review Board and piloted the recently implemented FPD electronic document routing system that has drastically reduced the time it takes to process key project documents through the Center. She continued to reorganize the Division to focus on its strengths and ensure her team is engaged in FPD initiatives and improvements. Currently, Cathy oversees ten projects in varying phases of development at the Jet Propulsion Laboratory, Langley Research Center, and Goddard, as well as the Earth Science Mission Operations (ESMO) project for all operating Goddard missions and Earth Science Data and Information Systems (ESDIS) for all Earth science data across the Agency.

At the Directorate level, Cathy participates in the Women of Flight and Diversity and Inclusion committees and is excited to participate in the FPD Executive Roundtables to continue to improve the FPD community and its objectives.

Life Outside Goddard

Cathy lives in Columbia, Maryland with her husband and son and enjoys golfing, bowling, and cooking in her spare time. ■

"I wouldn't be where I am today if I didn't take risks; don't be afraid to make a change."

Jennifer Poston

Flight Projects Directorate Office (400)

Integrated Program Team Lead, PAAC Contract

Born Baltimore, Maryland

Education Master's in Business Administration, University of Phoenix; Bachelor of Arts, Salisbury University

Jen Poston began working at Goddard Space Flight Center (GSFC) in 2004 supporting the Structure and Evolution of the Universe (SEU) division and helped coordinate the Project Management Challenge prior to joining the Flight Projects Directorate (FPD) where she has supported information technology process improvement projects, SharePoint, and other business analysis opportunities for the past 9 years.

Life Before Goddard

Jen grew up in Laurel, Maryland and frequently visited Goddard as a young child. She was a part of the Goddard Child Development Center and would never miss a take your daughter to work day. She often fought with her three sisters over who would go. She attended Salisbury State University (now known as Salisbury University) where she earned a Bachelor of Arts degree with a minor in Business Administration. After graduation, she moved back home and found a job on the Program Analysis and Control (PAAC) contract and hasn't looked back.

Life at Goddard

Jen began work in the Structure and Evolution of the Universe (SEU) division where she supported projects like the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO), Laser Interferometer Space Antenna (LISA) and the Project Management Challenge. She started doing graphic design and web development for the division. When the division dissolved, she worked with the NASA Academy of Program/Project and Engineering Leadership (APPEL) program in conducting the NASA PM Challenge, where she was responsible for the graphics, website, and logistical aspects of the conference. She was also provided an opportunity to work on proposal efforts supporting the New Opportunities Office where she helped with proposal graphics. From there, she was asked to join the Flight Projects Directorate office and focused on SharePoint and business processes to help with automating tasks for the directorate.

Life Outside Goddard

Jen and her significant other, Jamie, sons David, Anthony, and JB, operate his family farm, TLV Tree Farm in Glenelg, Maryland. The farm is one of only a handful of working farms left in Howard County, Maryland and is part of the farmland preservation program; the land must always be farmed and never developed. The farm involves a vast variety of projects. The family members grow a variety of vegetables and fruits and are known for their tomatoes, corn, green beans, squash, lettuce, potatoes, okra, and strawberries. They raise beef, pork, turkey, and chicken, all of which are free-range, with no hormones, no antibiotics, and no genetically modified organisms (GMO). They take these items to local farmers' markets and have a community supported agriculture (CSA) share program. In the fall the farm provides fall activities which include 'pick your own pumpkins,' a 10-acre corn maze, educational tours, and farm activities. Then in November/December they grow 52 acres of planted Christmas trees for people to come and cut their own tree.

Former Howard County executive, Ken Ulman, tries his hand at juggling tomatoes during the Farm Job Exchange. CREDIT: HOWARD COUNTY TIMES

Jen watering a recent crop. CREDIT: HOWARD COUNTY TIMES

Jen never thought she would end up helping to operate a farm, but she wouldn't have it any other way. She thinks that the work she does for Goddard closely relates to the work on the farm as it is customer-focused and she loves to see people enjoying what they are doing. Jen and Jamie think at least one of their boys will grow up to be a farmer and take over the legacy, but time will tell. ■

TLV's greenhouse is full of herbs, flowers and all sorts of treats. CREDIT: JEN POSTON

Farmer Brown camp teaches children how agriculture relates to STEM. CREDIT: JEN POSTON

Christmas on the Farm. CREDIT: DAVID BROWN

"Thinking positively isn't about expecting the best to happen every time, but accepting that whatever happens is the best for this moment."

- unknown

Coming and Goings

October 1, 2018 through March 31, 2019

Comings

Paul Stysley (GSFC-554) – detailed to 401/Proposal Formulation and Development Office (PFDO) mission pre-formulation manager

Dr. Gyanesh Chander (GSFC-586) – Reassigned to 416/Geostationary Operational Environmental Satellite (GOES) Ground deputy project manager

Jerry Esper (700) – Reassigned to 400/FPD Directorate Office, assistant director for information technology

Neerav Shah (595) – Reassigned to 401/PFDO study manager

LaMont Ruley (583) – Detailed to 460/ Explorers and Heliophysics Projects Division (EHPD) mission manager

Tyrone Dillard (383) – Detailed to 460/EHPD mission manager

Goings

Jeff Volosin (460) – Detailed to Headquarters Science Mission Directorate (SMD)/Astrophysics Division

Cecilia Czarnecki (400) – Retirement from FPD Directorate Office

C. Lynn Myers (450.1) – Retirement from Networks Integration Management Office (NIMO)

John Loiacono (434) – Retirement from Lucy

Jackie Townsend (470) – Detailed to Headquarters/SMD/Astrophysics Division

Jermaine Starks (450) – Reassigned to Code 200

Lisa Shears (474) – Retirement from Joint Polar Satellite System (JPSS) Ground

Debbie Hamby (470) – Retirement from JPSS Program Office

Marco Toral (450.3) – Retirement from Search and Rescue

Bob Melis (417) – Retirement from GOES Flight

John Leon (425) – Reassigned to Code 550

James Marsh (443) – Reassigned to Code 540

Mansoor Ahmed (440) – Retirement from Astrophysics Projects Division

Keith Cleveland (448) – Reassigned to Code 383

Kevin Hughes (496) – Reassigned to Code 543

Bob Smith (407) - Retirement from Earth Science Technology Office

Julie Crooke (401) – Reassigned to Code 100

Reassignments/ Realignments Details within Code 400

Donald Whiteman (491) - Reassigned to 472/JPSS Flight instrument manager

Joy Henegar-Leon (425) - Reassigned to 490.2/Resolve deputy instrument project manager

Todd King (401) – Reassigned to 483/Restore-L observatory manager

Barbara Grofic (470) – Detailed to 470 supervisory project manager

Jamie Dunn (443) – Reassigned to 448/ Wide Field Infrared Survey Telescope (WFIRST) project manager

Betsy Park (450.2) – Reassigned to 450.2/ Technical Enterprise Mission Pathfinder Office (TEMPO) supervisory project manager

Vickie Moran (460) – Reassignment to 401/PFDO study manager

Candace Carlisle (424) – Reassigned to 417/GOES Flight project manager

Thomas Griffin (448) – Reassignment to 448/WFIRST supervisory deputy project manager

Cathy Peddie (448) – Reassignment to 400/FPD associate director for strategy and integration

Dan Devito (474) – Reassignment to 400/FPD associate director for strategy and integration

Paul Richards (451) – Reassignment to 450.2/TEMPO mission manager

Juli Lander (443) – Reassignment to 451/ Laser Communications Relay Demonstration (LCRD) deputy project manager

Preston Burch (480) – Reassigned to 440/Astrophysics Projects Division associate director

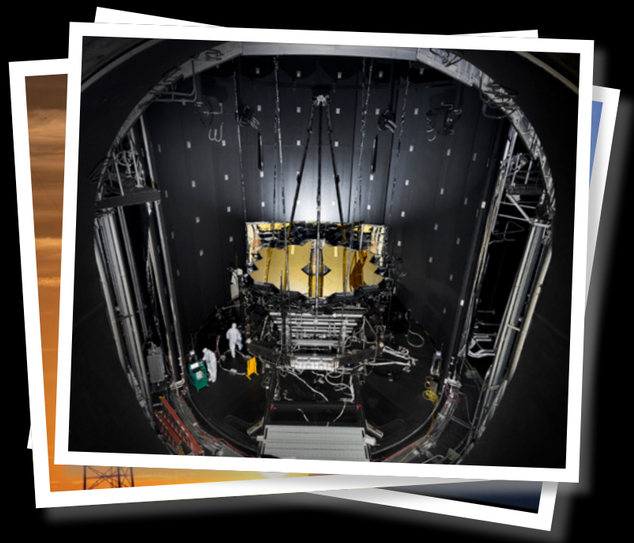
Antonios Seas (450.2) – Reassignment to 451/LCRD deputy project manager

Rosa Avalos-Warren (840 WFF) – Reassignment to 450.1/NIMO mission manager

Keith Walyus (490) - Reassignment to 472/JPSS Flight deputy project manager

Susan Breon (480) - Reassignment to 424/ Total and Spectral solar Irradiance Sensor (TSIS) project manager

Karen Rogers / Code 400
Administrative Officer



FEATURED IN

NATIONAL GEOGRAPHIC

Taking hundreds of technical photographs every day for ten years for the James Webb Space Telescope is a dream come true for photographer Chris Gunn. Having one of his images featured in the March 2019 issue of National Geographic is a special reward for a job well done. The 33-page article, "We Are Not Alone" describes present and future efforts to search for life outside of our solar system and Webb is featured. Chris's 2017 photo of the Webb telescope tucked inside Johnson Space Center's massive cryogenic chamber was chosen to accompany the article. ■

To view the complete article, go to: https://www.nationalgeographic.com/magazine/2019/03/extraterrestrial-life-probably-exists-how-do-we-search-for-aliens/

Maureen Disharoon / Code 443
JWST Data Manager

KNOWLEDGE MANAGEMENT *Insights*

Team Performance and Psychological Safety

Many Goddard employees are addressing impacts from the longest government shutdown to date, in addition to the Mission Support Future Architecture Program (MAP) transformation, ongoing budgeting, and new Space Policy. Ever timely is Amy Edmonson's assessment that psychological safety is a key ingredient for high-performing teams in a complex, changing environment. Amy Edmonson, Harvard professor, participated in a 2012 Center event on 'Organizational Silence.'

In February 2016, a 5-year study at Google concluded with the most important dynamics of successful teams. The top five were: 1. Clear goals 2. Dependable colleagues 3. Personally meaningful work 4. A belief that the work has impact and 5. Psychological safety, which is the most important of the five because it undergirds the other four.

What is psychological safety? According to Edmonson, psychological safety is a source of value creation in organizations. In a psychologically safe workplace, people are not hindered by interpersonal fear. It is vital in helping people overcome anxiety or defensiveness, especially when things do not go as expected. People are comfortable speaking up; concerns can be raised, mistakes are quickly reported; teams and functions seamlessly coordinate across silos. Organizations that prioritize psychological safety also see improvements in physical safety.

Lessons learned, a key knowledge management (KM) component, is integral to safety. A project, in accordance with NPR 7120.5, is expected to pay attention to lessons learned from other projects and documents its lessons to benefit future projects. The Flight Projects Directorate KM liaison can support projects, at no cost, in developing a Lessons Learned Plan. Another service is facilitating Pause and Learn sessions. The Pause and Learn (PaL) was introduced to Goddard by Ed Rogers, Chief Knowledge Officer.

The PaL is a group discussion during which a project team identifies and captures knowledge at key project stages. Observations are documented in Knowledge Maps (KMaps). A Knowledge Map is a visual representation, highlighting valuable insights and comments within the context of the conversation. PaL lessons can have an immediate impact on a project and offer longer-term value to other projects.

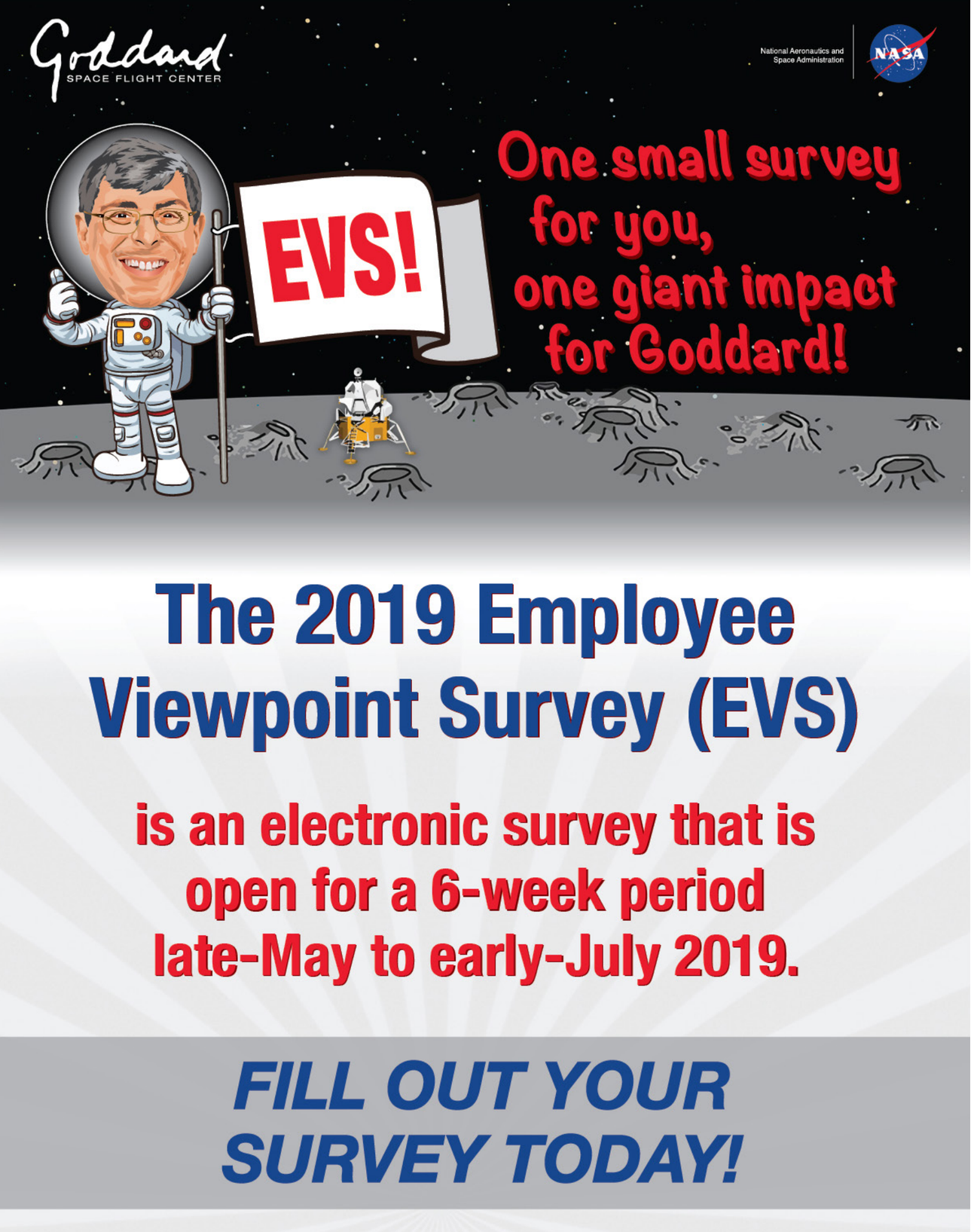
The PaL, a group learning event, establishes guidelines for non-attribution; criticism is levelled at process, not people. Hierarchy is temporarily set aside; everyone has an equal opportunity to speak up. Issues can be addressed that do not typically come up in traditional staff meetings or one-on-one conversations. Assumptions can be challenged and silent concerns or issues may be surfaced. Consideration of diverse views and perspectives is validated. In times of increasing complexity and speed, the PaL is a timely opportunity to slow down, reflect and learn. ■

Judy Dickinson / Code 400
FPD Knowledge Management Lead

> "Psychological safety is about candor, about making it possible for productive disagreement and free exchange of ideas. It goes without saying that these are vital to learning and innovation. Conflict inevitably arises in any workplace. Psychological safety enables people on different sides of a conflict to speak candidly about what's bothering them."
>
> **Amy Edmonson**

For more information:

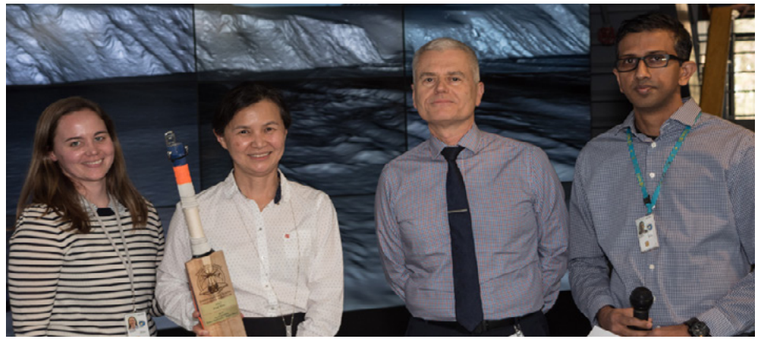
- Edmonson, Amy, *The Fearless Organization*, 2018
- NPR 7120.5 E
- Pause and Learn Brochure
- Goddard Knowledge Exchange



Congratulations to Eileen Mitchell/443 and her husband Jim on the birth of their daughter, Lila Joanne. She was born on October 21, 2018, weighing 7 lbs, 2.5 oz. She was 19 inches long.

Best wishes to Amanda Majstorovic/401, and Jason Overstreet on the birth of their son, Tripp. He was born on March 15, 2019, weighing 6 lbs, 12 oz, and was 19 inches long.

Trisha Aldridge/452 is excited to welcome her fourth grandchild, Rory, born on November 18, 2018, weighing 8 lbs., 14.5 ounces, and 21 inches long.



Jae Lee (JCET/UMBC) (second from left) and Dong L. Wu (613) were awarded the Piers J. Sellers Award for Interdisciplinary Science by the Director of Sciences and Exploration Directorate/GSFC, Mark Clampin (second from right), on February 26, 2019 at the 12th Annual New Year's poster party. Their poster "Is There a Time Lag between Total Solar Irradiance and Sunspot Area?" explores two fundamental quantities in Heliophysics and Earth Science: the solar magnetic field emergence and total solar energy input to Earth. To examine the relationship between the two, they showed SDO solar disc images, ground observations of sunspot area, and measured total solar irradiance data from the SORCE, TCTE, and newly launched TSIS-1. Also pictured are the poster party organizers, Lauren Andrews (610.1) (at left) and Sujay Kumar (617) (at right).

OUT & ABOUT

LIFE'S HIGHLIGHTS OFF CAMPUS

Share your news!
Weddings, births, interesting travel experiences...we want to know!

Please send your inputs to Paula Wood. Include your **name, phone number** to:

paula.l.wood@nasa.gov
Code 460
Ext. 6-9125

THE LATEST SAR SAVES

NASA'S SEARCH AND RESCUE (SAR) OFFICE CONTINUES ITS EFFORTS TO DEVELOP AND IMPROVE ON LIFE-SAVING DISTRESS BEACON TECHNOLOGIES.

Each icon on this map represents one rescue event, though multiple saves may be involved with each event. The Search and Rescue Satellite Aided Tracking (SARSAT) system is able to detect three types of beacons:

Personal Locator Beacons (PLBs)

Used primarily by hikers and outdoor enthusiasts

Emergency Position Indicating Radio Beacons (EPIRBs)

Used by commercial and recreation ships

Emergency Locator Transmitters (ELTs)

Used by civilian aircraft

COSPAS-SARSAT rescues from April 2018 through April 2019 are shown above.

DID YOU KNOW...?

Did you know the Peruvian Quechua have a history in Peru tracing back thousands of years before the Incan empire? Quechua is the co-official language in Peru along with Spanish.

We want to be in the know!

If you have something to share, send it to Matthew Ritsko. Include your **name, phone number** and send it to:

matthew.w.ritsko@nasa.gov

Code 400 Diversity and Inclusion Committee

Ext. 6-2515

FLIGHT PROJECTS DIRECTORATE

SENIOR LEADERSHIP ROUNDTABLE

The Flight Projects Directorate (FPD) Roundtable is comprised of senior leaders within FPD, engaging in strategic initiatives for the good of the organization, Center and Agency. This effort creates a shared leadership vision, providing a forum for identifying our competitive advantage as well as our institutional barriers, and for discussing what collaborative actions could be executed within 400's control. There is an intentional push by directorate leadership to keep the momentum going, which has already resulted in a change to the FPD Tag-Ups once a quarter to allow for the Roundtable to dedicate a half day to work strategic initiatives. The Roundtable meets monthly and has divided FPD priorities into four initiatives. We are sharing our Strategic Initiatives with the FPD community and each meeting will focus on a different element. In our latest meeting, we focused on "Stakeholder and Partner Relationships" and planned initiatives are highlighted in green in the graphic below. ■

DR. WANDA PETERS / Code 400
FPD DEPUTY DIRECTOR FOR PLANNING AND BUSINESS MANAGEMENT

Flight Projects Directorate (FPD)/Senior Leadership Strategic Initiatives

Purpose of FPD Roundtable - Enhance Goddard's program/project management, nurture our people, influence the external environment to sustain world class capabilities, and achieve mission success by cultivating a strategic and collaborative directorate.

The strategic competitive advantage of GSFC's FPD is multifaceted; enabling us to create an environment in which to accomplish our dynamic mission. Control of our resources enables us to be empowered to accomplish our mission. We strive to maintain and improve on being the premier program/project management organization at NASA which we accomplish through our **experience** and our **people**:

- We leverage and harness the experiences and passion of our people, to accomplish multiple missions and to collaborate for future work in a dynamic environment, enabling us to execute on a diversity of short/long term missions.
- We come to the game rooted in the experience base of our flight projects culture, with an agility and flexibility that serves our stakeholders and partners in the accomplishment of the mission.
- Our people get the job done in an environment of ever changing challenges.

FPD Roundtable Team Updates

FPD Initiative: Our People
- Champion: Wanda Peters
- Co-Leader – Donna Swann
- Co-Leader – Barb Haskell/155
- Team Members
  - Nick Chrissotimos
  - Cindy Fryer
  - Subject matter experts

FPD Initiative: Shared Leadership
- Champion: Tom McCarthy
- Co-Leader – Bob Menrad
- Co-Leader – Preston Burch
- Team Members
  - Nick Chrissotimos
  - Donna Swann
  - Bill Ochs
  - Pam Millar
  - Subject matter experts

FPD Initiative: Continuous Improvement
- Champion: Wanda Peters
- Co-Leader – Cathie Peddie
- Co-Leader – Ken Schwer
- Team Members
  - Rich Ryan/155
  - Art Jacques
  - Subject matter experts

FPD Initiative: Stakeholder and Partner Relationships
- Champion: Tom McCarthy
- Co-Leader – Cathy Richardson
- Co-Leader – Rich Ryan/155
- Team Members
  - Ken Schwer
  - Subject matter experts (Dan Blackwood)

Five common themes and potential actions were identified through meetings with other directorates.

Provide better communication paths to help resolve project manager (PM) concerns/issues with other directorates: Encourage PMs to talk to appropriate levels of management in each directorate. Communicate staff roles and responsibilities.

Continue partnership meetings/tag-ups: Directorates encouraged PMs to initiate, or continue to have, strategic discussions.

PM leadership support for science studies and pre-phase A efforts: Commit PMs to support study efforts and ensure study managers are not undervalued.

Build new and enhance existing competencies: FPD to expand PM competencies and expertise in small satellite constellation management. FPD and projects to work with other directorates to build and maintain GSFC core competencies.

Continue diversity across PM discipline: FPD to support more women and minorities in PM roles, as well as other senior project and program leadership roles.

FPD FEST '19

TUES. JUNE 18TH
12:00PM-2:30PM
BUILDING 8 AUDITORIUM

Enjoy food, games, door prizes, networking, and RITA's Italian Ice!

Featuring the **Peer Awards** and **FPD Achievements**

TICKET PRICE: $5
TICKETS ON SALE THROUGH JUNE 12TH

See FPD members in each building for ticket sales:

Buildings 3 / 13 / 14: Stephanie Mullen – Room 204, 6-3843
Building 5: Holly Wyrostek – Room C060, 6-3731
Building 6: Maria Fleming, Nicole Solomon – Room C100, 6-1355
Buildings 7 / 10 / 15: Gail Dellagatta – Room 287, 6-1126
Building 8: Alicia Jose, Kerri Anderson – Room 240, 6-6307
Building 12: JoAnn Brasted – Room C210, 6-2586
Building 22: Susan Wright – Room 308, 6-2201
Building 23: Phill Blackwood – Room E137, 6-8435
Building 29: Laura Paschal – Room 200, 6-4176
Building 32: Diane Trakas, Selene Annadale – Room S240, 4-5048
Building 33: Chris Beeg, Lori Winter – Room E122, 4-5634
Building 36: Rachel Brinson, Faiza Hartnett – S402 or S430G, 6-9696
JPSS Building: Donna Warthen – L40A, 4-0501